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STRANGE SEA ASYMMETRY FROM GLOBAL QCD FITS

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We present a preliminary account of a new global QCD analysis of DIS data, including recent $\nu, \bar{\nu}$ DIS measurements. The model-independent cross section reanalysis by CCFR allows a new determination of the strange sea asymmetry, whose first moment is found to be small. The impact on the NuTeV measurement of $\sin^2 \theta_W$ is discussed.

1 QCD analysis and parton distributions

This analysis, which is an update of [1], aims at extracting flavour-separated parton distributions from a global NLO QCD analysis of inclusive DIS and Drell Yan cross sections. The data set used [2] ranges from the cornerstone DIS data of BCDMS and NMC, including recent data from HERA (neutral and charged current from H1 and Zeus), to the fixed-target Drell-Yan measurements of E866, E605 and E772. As for neutrino DIS, CCFR cross section measurements - now available [3] as a model independent result - together with the CDHSW data provide key constraints for the strange sea determination.

The parton distributions $g, u_v, d_v, \bar{u}+\bar{d}, \bar{d}-\bar{u}$ and s, \bar{s} are parametrised and evolved in the NLO Fixed-Flavour Scheme. The strange sea is not constrained to have the same shape as the light sea, and $s \neq \bar{s}$ is allowed with the condition $\int_0^1 (s - \bar{s}) dx = 0$ that ensures zero net strangeness. Details of the fit can be found in [1] and in a forthcoming paper.

2 Extraction of the strange sea asymmetry

Our focus in this communication will be on the strange sea asymmetry $s - \bar{s}$. The requirement $s = \bar{s}$ is not dictated by any symmetry of QCD, and qualitative

models predict a significant asymmetry in the high x region arising from long-living higher Fock states containing intrinsic $s\bar{s}$ pairs [4].

Experimental constraints on $s - \bar{s}$ come from charged current ν and $\bar{\nu}$ cross sections: the quantity

$$\frac{d^2\sigma^{\nu N}}{dx dQ^2} - \frac{d^2\sigma^{\bar{\nu} N}}{dx dQ^2} \propto xs - x\bar{s} + [1 - (1 - y^2)](xu_v + xd_v) \quad (1)$$

valid at LO for an isoscalar target, exhibits the sensitivity to the strange sea asymmetry (valence distributions are well constrained by other data). Both CCFR and CDHSW provide high x data: the latter tend to be higher for neutrinos (see figure 1), whereas the two series of data are in agreement for antineutrinos. The NuTeV Collaboration has recently released new data on $\nu, \bar{\nu}$ DIS with dimuon production [5]. These data are not statistically significant for $x > 0.5$ but constrain the strange sea at small x and affect indirectly the large- x region because of the strange number sum rule $\int (s - \bar{s})dx = 0$. Unfortunately, NuTeV data cannot be included in a global cross section fit in the form they are published.

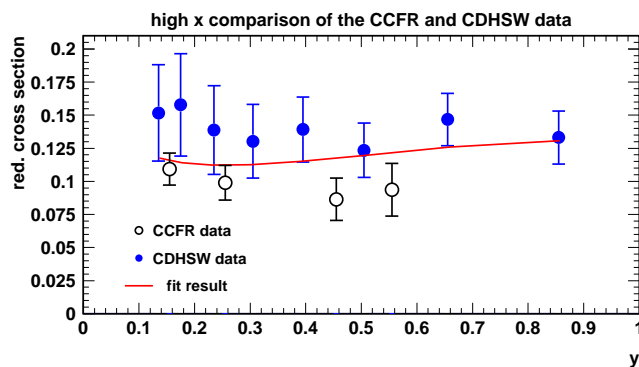


Figure 1: Comparison of the reduced neutrino cross sections of CCFR and CDHSW for $x = 0.65$ and $E_\nu = 110$ GeV. The normalisation shifts determined by the fit are applied.

With both CDHSW and CCFR data sets we found that the strange sea asymmetry is $\int x(s - \bar{s})dx = (1.8 \pm 3.8) \times 10^{-4}$ (see figure 2). Removing the CCFR data leads to a larger asymmetry, $\int x(s - \bar{s})dx = (1.8 \pm 0.5) \times 10^{-3}$, as already

shown by our previous results [1]. It should be noticed that the dominant systematic uncertainty (flux normalisation) for CCFR neutrino data is fitted to -5.2σ (the data are scaled up by 4%), irrespectively of the assumptions on the strange sea. On the other hand, there is the well known problem of the CDHSW y shape for $x < 0.1$ which do not follow the QCD prediction. A reasonable attitude is to take both data sets into account in the global analysis keeping in mind that one of them or both may be affected by uncontrolled experimental effects. A recent study by CTEQ [6], which includes the NuTeV dimuon data, shows that these data drive a bump of $s(x) - \bar{s}(x)$ in the medium-large x region, in qualitative agreement with the findings of [1].

3 Impact on the NuTeV $\sin^2 \theta_W$ measurement

The NuTeV experiment uses a fit to the measured ratios of neutral current to charged current cross sections $R^{\nu(\bar{\nu})} = \sigma_{NC}^{\nu(\bar{\nu})} / \sigma_{CC}^{\nu(\bar{\nu})}$ to extract $\sin^2 \theta_W$. They obtain $\sin^2 \theta_W = 0.2277 \pm 0.0016$ [7] which is 3.1σ away from the fit result by the LEP EWWG of $\sin^2 \theta_W = 0.22272 \pm 0.00036$ [8]. A related quantity is the Paschos-Wolfenstein ratio $R^- = (\sigma_{NC}^\nu - \sigma_{NC}^{\bar{\nu}}) / (\sigma_{CC}^\nu - \sigma_{CC}^{\bar{\nu}})$, given by $R^- = 1/2 - \sin^2 \theta_W$ at LO for an isoscalar target. Discussion of the NuTeV determination of $\sin^2 \theta_W$ in the context of the present work is relevant since R^- must be corrected if there is a fractional neutron excess δN or if $s \neq \bar{s}$. In this case R^- reads [9, 10]

$$\begin{aligned} R^- &= \frac{1}{2} - \sin^2 \theta_W - \left(\delta N \frac{\int x(u_v - d_v) dx}{\int x(u_v + d_v) dx} + \frac{\int x(s - \bar{s}) dx}{\int x(u_v + d_v) dx} \right) \\ &\quad \times \left[1 - \frac{7}{3} \sin^2 \theta_W + \frac{8\alpha_s}{9\pi} \left(\frac{1}{2} - \sin^2 \theta_W \right) \right] \\ &\equiv \frac{1}{2} - \sin^2 \theta_W + \delta R^- \end{aligned} \quad (2)$$

The correction δR^- as well as a properly propagated error can be computed using the parton distributions of this analysis. With all data sets one obtains $\delta R^- = -0.0107 \pm 0.0005$, without the CCFR data set the significant strange sea asymmetry leads to the value $\delta R^- = -0.0135 \pm 0.0008$. whereas the NuTeV collaboration reports the value [11] $\delta R^- = -0.0080 \pm 0.00005$. Taking the difference between these corrections one can roughly estimate the corresponding

shift of $\sin^2 \theta_W$: without the CCFR data the strange sea asymmetry has the required magnitude to reduce $\sin^2 \theta_W$ to 0.2222 ± 0.0018 , and with all data included $\sin^2 \theta_W = 0.2249 \pm 0.0017$, which is now 1.35σ away from the Standard Model fit value. Here the reduction is due to the neutron excess correction which is larger in our case, but approximately half of this discrepancy can be understood by taking into account the experimental cuts and cross talk between NC and CC using the model described in [12]. However for a realistic estimate a full MC study is required. Another relevant point is the parton distribution uncertainty, which is found to be one order of magnitude larger than the reported NuTeV value.

Since the [11] the NuTeV collaboration have re-evaluated this parton distribution error adjusting the value¹ 0.00005 to 0.0003 [13]. Note that the error in the evaluation have been independently found and originally reported to the NuTeV collaboration by S. Alekhin and S. Kulagin.

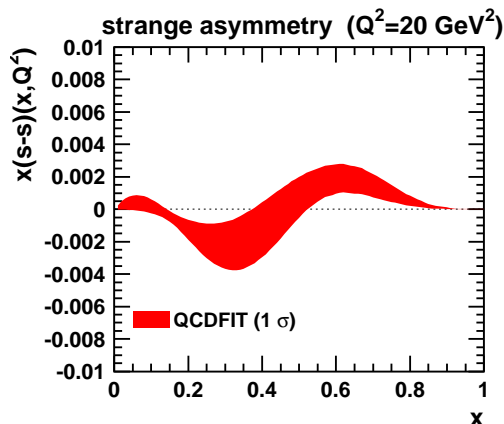


Figure 2: The strange sea asymmetry (one sigma error band) as obtained with the global fit including all data.

¹These numbers replace the mistyped values contained in the DIS03 proceeding.

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